

**Sonic Booms and Marine Mammals:
Informational Status and Recommendations**

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Figure 1

Outline of presentation.

SONIC BOOMS AND MARINE MAMMALS

Bill Cummings

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INTRODUCTION TO MARINE MAMMALS

Baleen Whales

Toothed Whales

Seals & Sea Lions

Sea Otter

Polar Bear

Manatees

MARINE MAMMAL HEARING

Baleen Whales

Toothed Whales

Seals & Sea Lions

NOISE EFFECTS

Explosives

Other

SONIC BOOMS

In Air (understood)

In Water

SONIC BOOM EFFECTS ON MARINE MAMMALS

Real Stimulus

Simulated Stimulus

PREDICTIONS

Submerged or Swimming

Hauled Out (Pinnipeds)

RECOMMENDATIONS

Contact With NRC, NMFS and MM Commission

Symposium (with SMM)

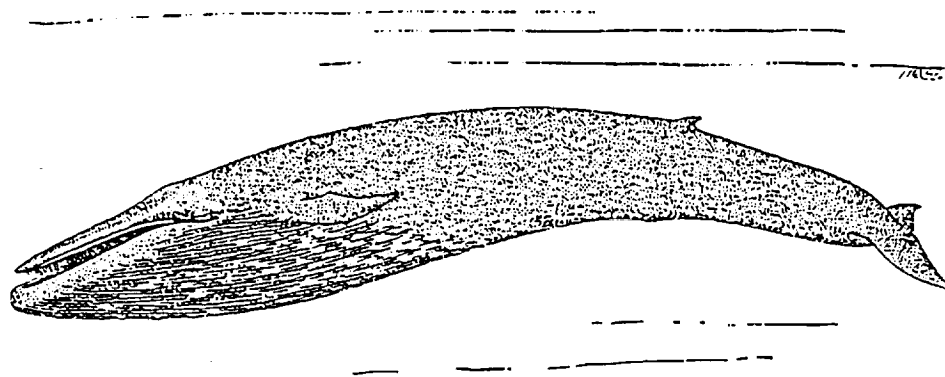
SSB Tests on Captive Porpoises & Pinnipeds

Habituation Tests

Figure 2

Examples of baleen (blue whale, top) and toothed (bottlenose dolphin, bottom) whales.

Balaenoptera musculus



Tursiops truncatus

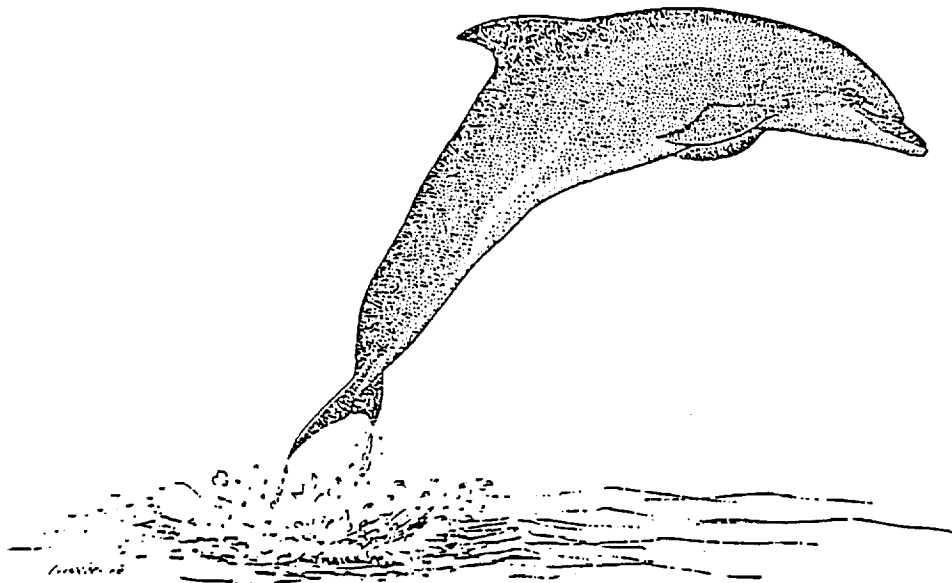
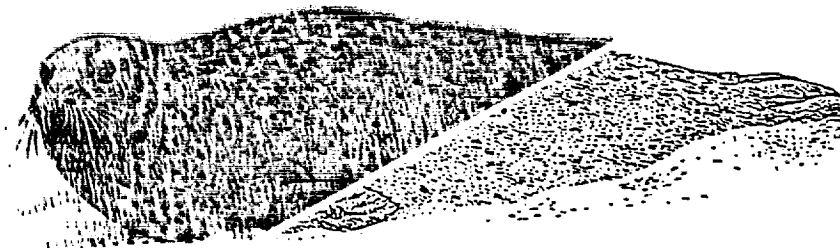


Figure 3

Examples of pinnipeds: harbor seal (top), California sea lion (bottom).

Phoca vitulina



Zalophus californianus

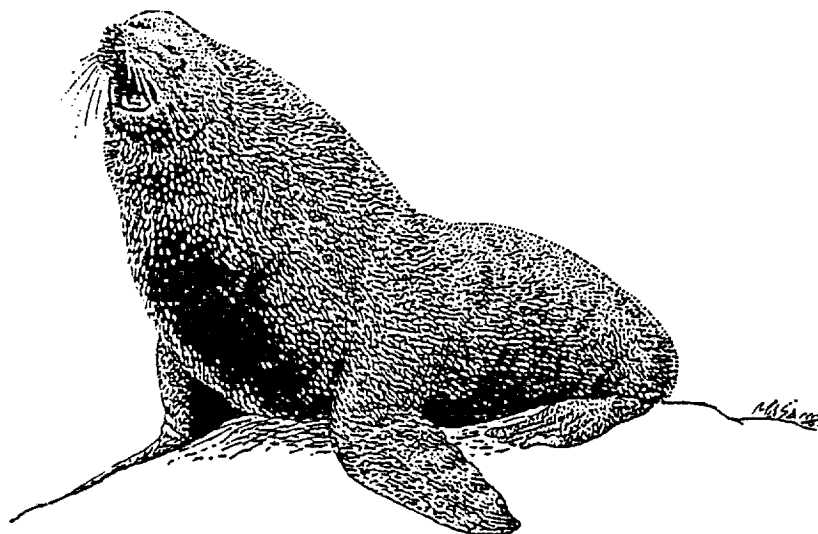


Figure 4

Examples of other marine mammals: Amazon manatee (top), sea otter (bottom).

Trichechus inunguis

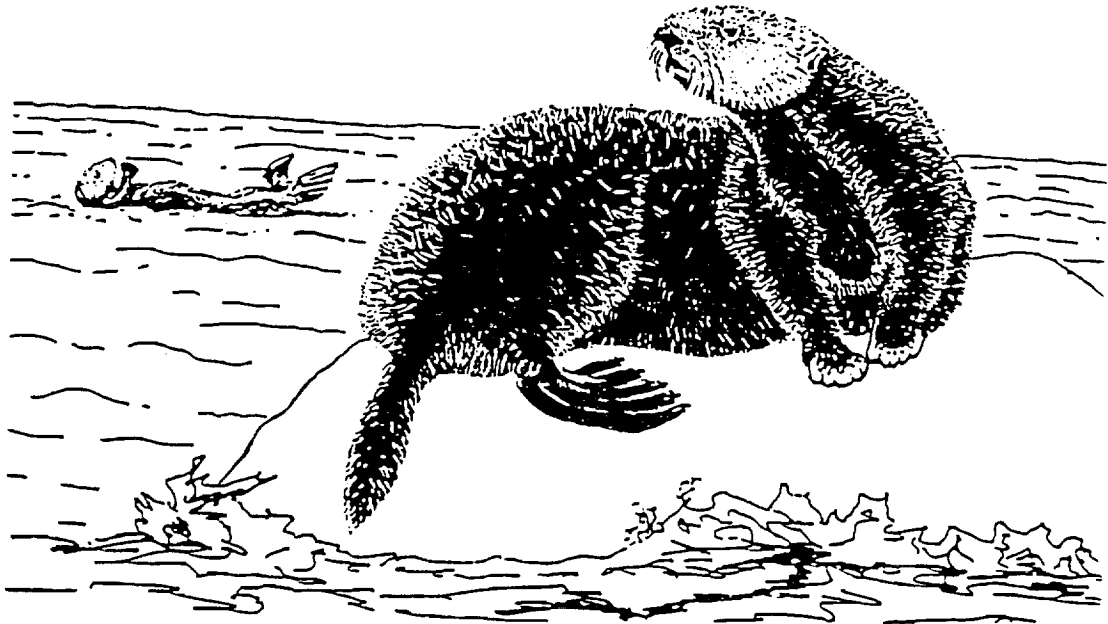
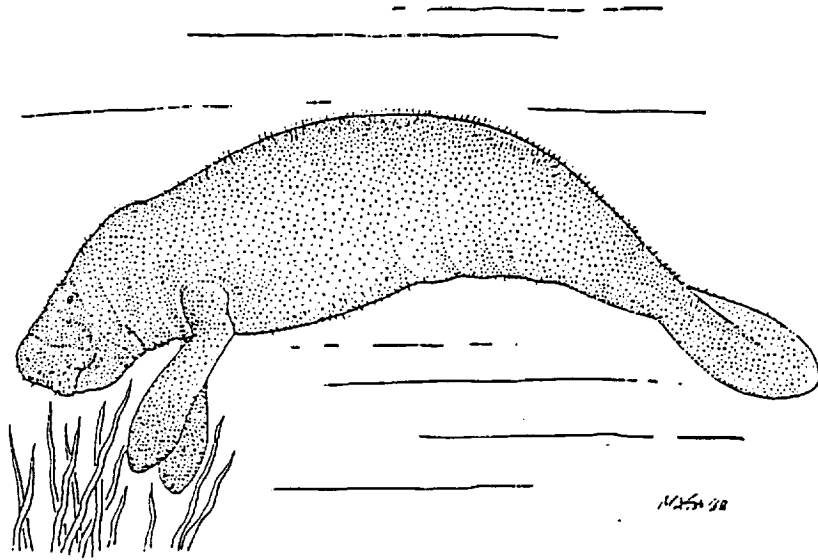


Figure 5

Estimated population sizes of selected large whales (from Gaskin).

WHALE	POPULATION SIZE
Sperm Whale	over 567,800
Bowhead Whale	about 2,500
Right Whale	about 3,500
Gray Whale	between 7,000-15,000
Humpback Whale	between 3,000-5,000
Blue Whale	between 7,000-13,000
Fln Whale	about 88,000
Sel Whale	about 130,000
Bryde's Whale	over 80,000
Minke Whale	between 113,000-646,780

THE BEST ESTIMATES OF LARGE WHALE POPULATION SIZES (DATA FROM
GASKIN 1982).

Figure 6

Sound source levels of selected species of marine mammals (various sources).

MARINE MAMMAL SOUND SOURCE LEVELS	
	<u>dB re 1 μPa, 1m</u>
Baleen Whales	131 - 189
Toothed Whales	135 - 200
Seals	95 - 180
Sea Lion, Walrus	157 - 172

Figure 7

Audiograms of five toothed whale species (from indicated sources).

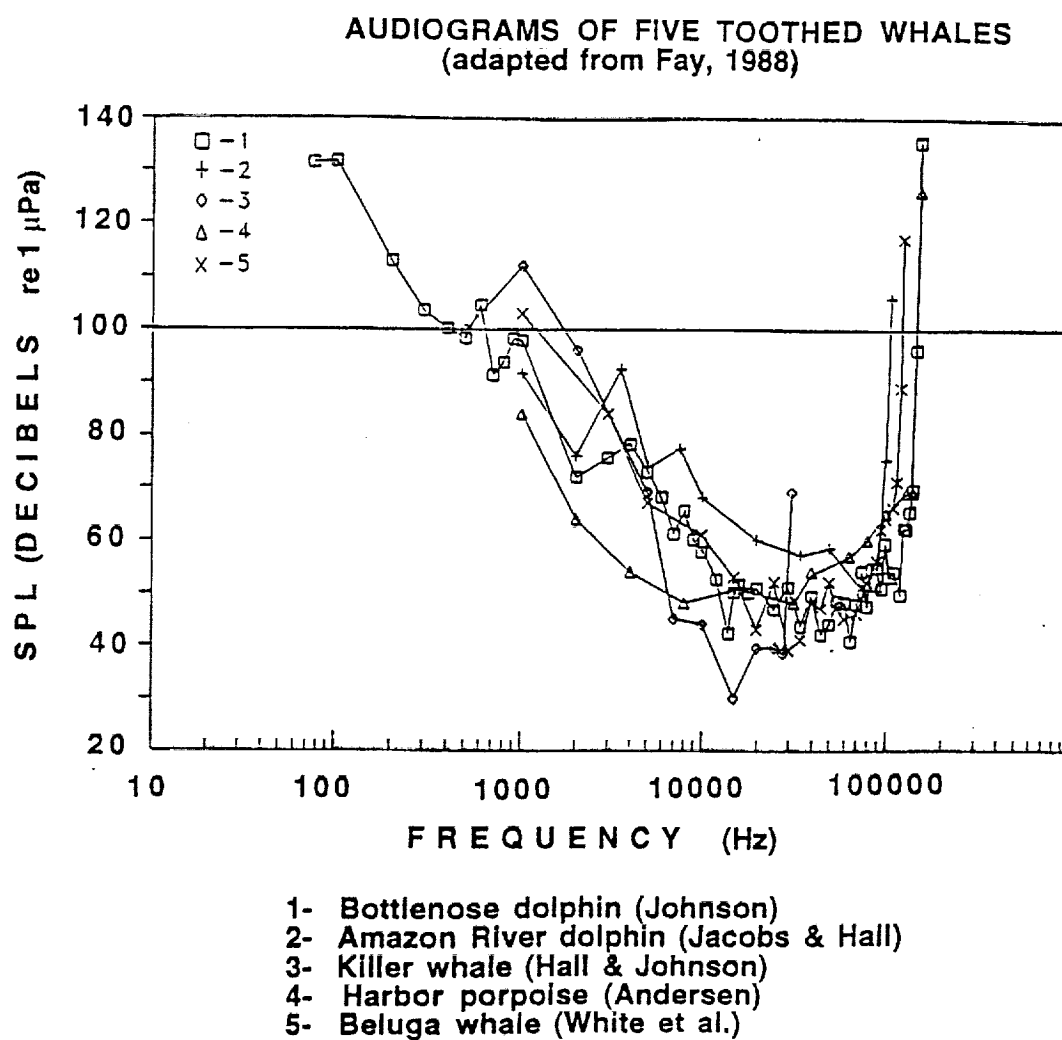
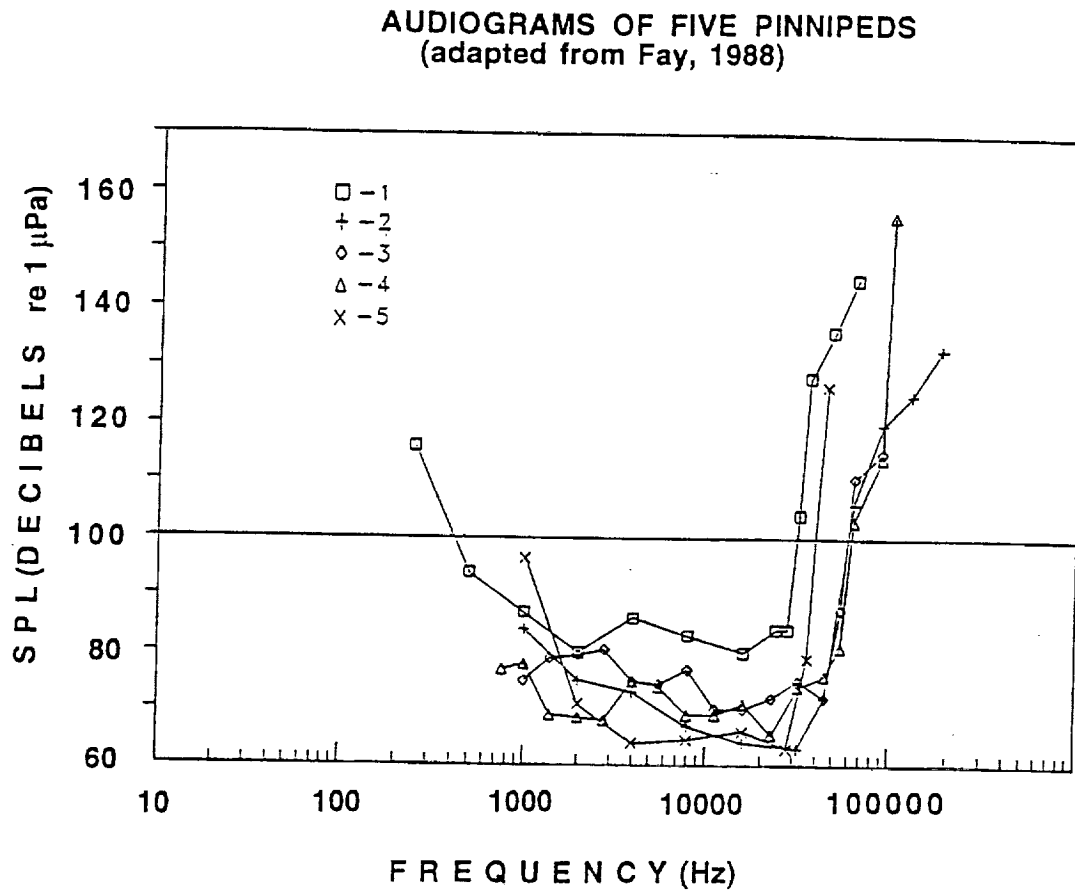


Figure 8

Audiograms of five pinnipeds (from indicated sources).



- 1- California sea lion (Schusterman et al., 1972)
- 2- Harbor seal (Mohl, 1968)
- 3- Ringed seal (Terhune & Ronald, 1975)
- 4- Harp seal (Terhune & Ronald, 1972)
- 5- Northern fur seal (Schusterman & Moore, 1978)

Figure 9

Sound spectra from a sonic boom at the water's surface and at depths indicated, compared to spectra of typical, low and high oceanic ambient noise (after Cook).

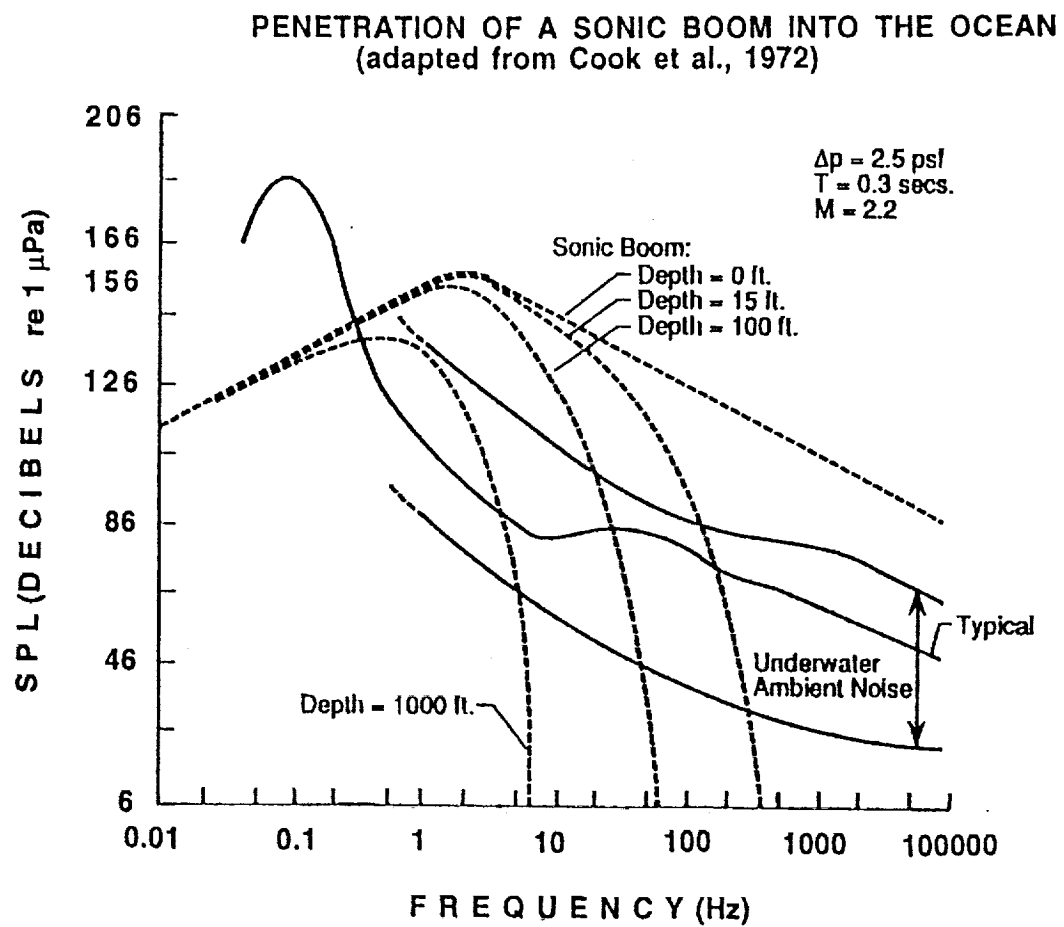


Figure 10

Sound spectrum of a sonic boom as measured at 15 ft depth, compared to average hearing curves of selected pinniped and toothed-whale species.

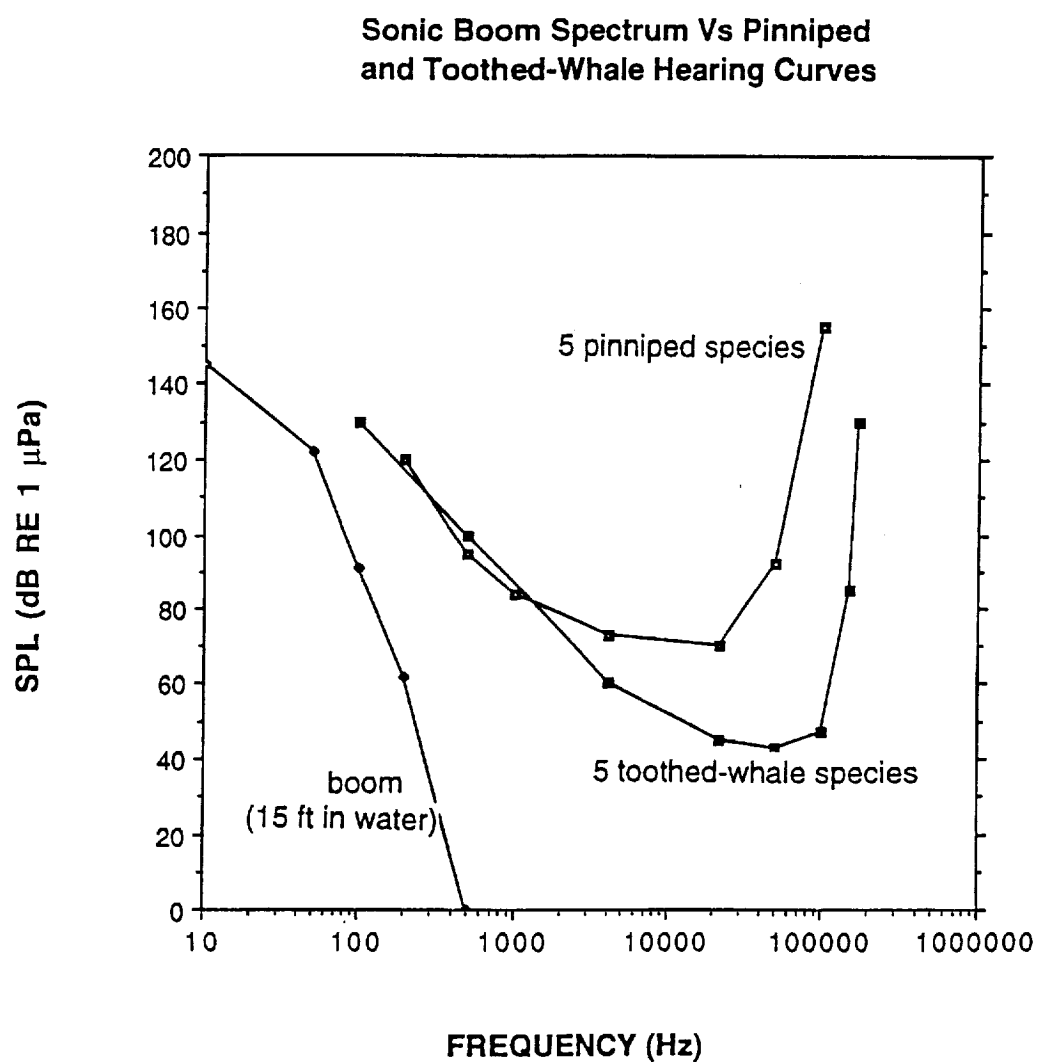


Figure 11

This study showed that marine mammal distributions will coincide with SS aircraft sonic booms. Depending upon the species and location, marine mammals will sense, not sense, or questionably sense sonic booms. Marine mammals probably will not be harmed physically. It is not probable that whale or swimming pinniped behavior will be significantly affected by sonic booms. Hauled out pinnipeds may or may not be affected by booms possibly depending upon species, age, and behavior at the time of the boom. There is little doubt that marine mammals will habituate to some extent.

CONCLUSIONS

COINCIDENCE +

SENSATION + - ?

DIRECT PHYSICAL HARM -

BEHAVIORAL EFFECTS

Whales -

Swimming Pinnipeds -

Hauled-Out Pinnipeds + - ?

HABITUATION + ?

Figure 12

There has only been one experimental study (Sea World) on one species of pinniped using simulated sonic booms and none based upon real booms. No studies have been undertaken on the effects of sonic booms on any other marine mammals. I recommend early contacts with the National Research Council and Acoustical Society of America committees, with the regulatory authorities at the National Marine Fisheries Service, and with the Marine Mammal Commission. Low cost, comparatively easily facilitated studies may be undertaken on captive porpoises and pinnipeds using simulated booms for the purpose of determining any effects or habituation. However, regulatory authorities may not require such studies. A marine mammal permit should be applied for well before any decision is made regarding technical feasibility of the overall program.

RECOMMENDATIONS

EARLY CONTACTS (NRC, ASA, NMFS, MM COMMISSION)

CONDUCT SYMPOSIUM (CONJUNCTION WITH SMM)

**SSB TESTS ON CAPTIVE PORPOISES & PINNIPEDS
(ONLY IF REQUIRED BY NMFS)**

**HABITUATION TESTS
(ONLY IF REQUIRED BY NMFS)**

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13. ABSTRACT (Maximum 200 words) The second High-Speed Research Program Sonic Boom Workshop was held at NASA Ames Research Center May 12-14, 1993. The purpose of this workshop was to provide a forum for government, industry, and university participants to present and discuss progress in their research. The workshop was organized into three sessions dealing with atmospheric propagation, acceptability, and configuration design. Attendance at the workshop was by invitation only. Volume I includes papers on atmospheric propagation and acceptability studies. Significant progress is noted in these areas in the time since the previous workshop a year earlier. In particular, several papers demonstrate an improved capability to model the effect of atmospheric turbulence on sonic booms. This is a key issue in determining the stability and, ultimately, the acceptability of shaped sonic booms. In the area of acceptability, the PLdB metric has withstood considerable scrutiny and is validated as a loudness metric for a wide variety of sonic boom shapes. The differential loudness of asymmetric sonic booms is better understood, too.				
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